

A COMPARISON OF MULE DEER SURVEY TECHNIQUES IN THE SONORAN DESERT OF CALIFORNIA

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Helicopter surveys, ground surveys, and interviews with hunters were compared as methods to obtain mule deer (*Odocoileus hemionus eremicus*) demographic data in the Sonoran Desert of southeastern California. No difference existed between results of aerial surveys and hunter interviews ($P > 0.50$), but samples from ground surveys were too small to allow a meaningful comparison. In our study area, it would not be practical to obtain an adequate sample using ground surveys, given the low observation rate and high cost associated with that technique. Interviews with hunters were conducted at no additional cost because public contacts were initiated as part of routine law enforcement activities during the deer season. Interviews may be a cost-effective method of obtaining demographic information for low-density deer populations where other sampling techniques are neither practical nor cost-effective.

INTRODUCTION

Mule deer (*Odocoileus hemionus eremicus*) are distributed widely over the Sonoran Desert of southeastern California (Bowyer and Bleich 1984). Low population densities (McLean 1940) and the reluctance of these deer to leave cover have hindered the acquisition of demographic data (Celentano and Garcia 1984). Interest in hunting these deer has increased substantially in recent years, thereby necessitating the development of efficient and economical methods of estimating population parameters. Our objectives were to: (1) compare demographic parameters obtained during aerial surveys, ground-based surveys, and hunter interviews; and (2) compare the costs associated with each of these techniques.

METHODS

The Sonoran Desert study area is located in and near the Chocolate Mountains, southeastern Riverside and eastern Imperial counties, California. The dominant vegetation type is creosote bush (*Larrea tridentata*) scrub (Paysen et al. 1980), and

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it is widespread in both mountainous and intermountain areas. Numerous large washes, supporting stands of palo verde (*Cercidium floridum*), ironwood (*Olneya tesota*), smoke tree (*Dalea spinosa*) and mesquite (*Prosopis* spp.), dissect the intermountain regions of the study area.

Annual precipitation averages approximately 7.5 cm, and occurs primarily during the summer (Bailey 1966). Naturally occurring water sources are few, but numerous man-made water sources have been developed to improve deer habitat within the study area. The Coachella Canal, on the west, and the Colorado River, on the east, also provide year-round sources of water. Deer densities in the study area are high compared to other areas within the geographic range of *O. h. eremicus* (Celentano and Garcia 1984).

We conducted our research from September to November, 1990. Temperatures are relatively high, and precipitation usually low during those months (Bailey 1966). We conducted aerial surveys in September and October, and ground surveys in September. To maximize public contact, interviews were conducted immediately before, and during, the deer hunting season (6 October-25 November).

Because sexual segregation is a phenomenon common among large, polygynous mammals (Bleich 1993, for review), it might be expected to influence the results of demographic surveys if not considered in survey design. With the exception of the breeding season, Scarbrough and Krausman (1988) observed sexual segregation throughout the year among desert-dwelling mule deer (*O. h. crooki*), and Bowyer (1984) noted that sexual segregation was maximized during the birthing season for *O. h. fuliginatus* inhabiting a mesic ecosystem. Deer in our study area breed during January and February, and fawns are born during August and September (Celentano and Garcia 1984); thus, our surveys occurred during a period of probable sexual segregation. Because sex ratios might be biased if surveys occurred in a single habitat type occupied preferentially by one sex or the other (Schaller and Junrang 1988), we sampled deer in creosote bush scrub as well as wash habitats, and in mountainous and intermountain areas.

We conducted September aerial surveys ($n = 6$) with a Bell 206 B-III turbine-powered helicopter and in October ($n = 2$) with a Bell UH-1 turbine-powered helicopter. Only experienced pilots (Bleich 1983) and observers participated in the aerial surveys. Because Hervert and Krausman (1986) did not observe deer come to water during mid-day, we assumed deer were not active at that time; hence, we conducted our surveys during periods when deer were thought to be most active (L. Lesicka, pers. comm.), primarily early morning and late afternoon. We pooled data from morning and evening flights prior to analysis.

For ground surveys, skilled observers drove predetermined routes during the early morning or late afternoon, and observations were made by the driver and one passenger. Distances driven, time and location of observations, and age and sex of all deer encountered were recorded. We pooled data from morning and evening ground surveys prior to analysis. Because part of the study area was closed to civilian aircraft, aerial and ground surveys were not coincident in all cases.

Hunters were interviewed by California Department of Fish and Game (CDFG)

wardens, or by other qualified personnel. The interviews consisted of a short series of questions about the number of deer seen, their relative ages, and the sex of those deer. Animals were classified as female or male adults based on the presence or absence of antlers, or as juveniles (fawns, sex undetermined). Additional data, including the date, location, time, and number of hunters in each party, were recorded. Interviews were conducted on an informal basis, during routine public contacts, and interviewees were not told how their responses would be used. Consistent with the hunting regulations in this area, we assumed that deer hunters could distinguish mature antlered deer from mature antlerless deer, and young-of-the-year (newborn fawns) from antlerless adults (including yearlings). Interviews were conducted in areas coincident with those surveyed by ground observers or aerial observers.

We compared total overall costs, as well as cost ratios (dollars/deer classified) as measures of survey efficiency. We compared relative frequencies of the ages and sex of deer classified during aerial surveys and hunter interviews using a log-likelihood ratio statistic appropriate for contingency tables (Zar 1984).

RESULTS

During 13.4 hours of helicopter surveys, we classified 77 deer in 42 groups (Table 1), for an overall observation rate of 5.7 deer/rotor-hour. For aerial surveys, the mean group size was 1.8 deer. Helicopter costs (actual survey time, ferry time, travel expenses, logistical support [Bleich 1991] and observer salaries and travel expenses) totaled \$7,863 for September. Although no expenses were incurred for helicopter services during October (because helicopter time was donated), we estimated the value of that service to be \$1,499 based on costs incurred during September. Using these figures, we estimated a cost of \$122/deer classified for aerial surveys.

Twelve deer in four groups were classified during 13 ground surveys (Table 1). The average group size was 3.0, and the overall observation rate was 0.04 deer/mile driven. No costs were incurred for ground surveys because vehicles, fuel, and personal services were donated by volunteers. However, we estimated the total value of these surveys to be \$1,900, and the cost/deer classified to be \$158.

Table 1. Frequency (and percent) of male, female, and juvenile mule deer in samples obtained during aerial surveys, ground surveys, and through hunter interviews, Imperial and Riverside counties, California, September-November, 1990.

Source of Data	Deer Classification ^a		
	Male	Female	Juvenile
Helicopter	17 (22.1)	48 (62.3)	12 (15.6)
Ground	2 (16.7)	7 (58.3)	3 (25.0)
Interview	34 (18.7)	110 (60.4)	38 (20.9)

^a Juveniles are fawns (generally < 4 months of age).

A total of 101 public contacts yielded observations of 182 deer (Table 1); it was not possible to calculate the mean size of deer groups because, in most cases, hunters reported total numbers of animals seen, by sex and age categories. No costs were incurred while obtaining these data, because interviews were conducted during the course of routine patrol and resource assessment activities.

The percentages of male, female, and juvenile deer classified during three types of surveys were remarkably similar (Table 1). Indeed, samples obtained from helicopter sampling and hunter interviews (Table 1) did not differ ($G = 1.16$, $P = 0.56$, 2 df). Samples from the ground surveys were too small to be compared in a statistically meaningful manner.

DISCUSSION

Our objective was to compare aerial surveys, ground surveys, and hunter interviews as methods of estimating population parameters of mule deer inhabiting a Sonoran Desert ecosystem in southeastern California. We found no significant differences between demographic data resulting from aerial surveys and hunter interviews, and the latter technique may be an appropriate alternative for estimating population parameters of low-density deer populations. We attempted to avoid biases by sampling in the 2 vegetation types occurring in the hunt zone, by minimizing the probability of sampling an individual animal > 1 time during any survey (Wehausen 1990), and by interviewing "parties" of hunters, rather than individuals, that composed hunter groups.

Ground surveys yielded observations of only 12 deer, despite the expenditure of > 40 person-days of effort, and > 330 vehicle-miles. Given the low return per unit effort, we do not consider vehicle-based ground surveys a viable method of obtaining demographic data in our study area. For example, if the ground observation rate remained constant, it would require approximately 250 person-days and 2,300 vehicle-miles to accumulate a sample equivalent to that obtained using a helicopter. It is unreasonable to assume that amount of effort would be available to us on an annual basis; however, we encourage other investigators to explore ground surveys, in lieu of aerial surveys, as a means of obtaining demographic data.

Relatively low aerial observation rates (5.7 deer/hour) during September and October probably reflect the low density of deer inhabiting the study area. During Autumn, deer may be more widely dispersed than during Summer, a result of somewhat lower ambient temperatures that allow deer to disperse farther from sources of free water. Aerial observation rates (J. R. Thompson, unpubl. data) during June 1990 (before any summer thundershowers had occurred, and a very hot time of the year) were 1.4 x those obtained during our Autumn surveys. Mean group size during June was 1.3 x that during Autumn, possibly a reflection of the less gregarious nature of mule deer during the birthing season (Bowyer 1985). Larger groups may be more easily seen from the air (Samuel et al. 1987), but the advantages of higher observation rates in June may be more than offset by the difficulty associated with distinguishing adult male and female deer, as antlerogenesis has only recently begun.

Aerial survey data are expensive, with a cost of \$122/deer observed. Demographic data obtained during interviews were indistinguishable from results obtained during aerial surveys, but confidence intervals of high precision could not be calculated. Interviews were conducted at no additional cost to CDFG, because they were obtained during other previously scheduled activities. Interviews appear to be a valid method for estimating demographic parameters for low-density deer populations inhabiting the Sonoran Desert of southeastern California. Moreover, this technique may be applicable to other deer populations where aerial or ground surveys are neither efficient nor cost-effective, and we encourage investigators faced with similar logistical and fiscal constraints to explore its utility.

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